

Applicants first analyze in detail JP '212.

The major purpose of the problems to be solved by JP '212.

JP '212 is directed to providing a Ti-containing steel in which there is contained TiN type inclusions having a length of not more than 10 μm , as conventional TiN type inclusions deteriorate the fatigue durability of a steel.

JP '212 attempts to solve the problem by proposing a refining method for the TiN type inclusions. Essentially JP '212 proposes using a raw material for the Ti-containing steel which does not contain any TiN type inclusions.

In accordance with JP '212, in JP '212, the raw material is melted by the sequential processes of VIM+ VAM or VIM+ Vacuum Electro-slag Melting. As a consequence, unavoidable TiN inclusions are refined. It is to be noted in this regard that VIM means Vacuum Induction Melting and VAM means Vacuum Arc Melting.

The reason that JP '212 uses a raw material for the Ti-containing steel which does not contain any TiN type inclusions is that TiN type inclusions contained in such a raw material cannot be removed by VAM (see col. [0005]).

In VAM processes, a molten metal pool is made to have a small size by controlling the rising rate of the pool, whereby the agglomeration time of TiN type inclusions can be shortened. This will result in fine TiN type inclusions being present in the solid steel product produced. See cols. [0009] and [0011].

As opposed to VAM processing, if one uses Vacuum Electro-slag Melting processing, TiN-type inclusions can be removed by the molten slag.

In this regard, a peculiarity of TiN-type inclusion should be noted. Even if the pure raw steel containing only Ti is used, Ti contained in the steel will combine with nitrogen in the air to form Ti inclusions during VIM. The thus formed TiN inclusions grow in a product ingot during cooling after VIM processing and in a molten steel pool which is formed during re-melting processing and, in fact, in a product ingot during cooling after such re-melting processing.

However, according to the processing in accordance with JP '212, it is possible to restrain the size of Ti-N inclusions to a size in the range of 6.8 to 9.8 μm , even after such growth. This basically means that following the TiN inclusion refining method of JP '212, it is possible to restrain the growth of TiN inclusions to a degree which is extremely small or low.

Thus, JP '212 does not teach or suggest the concept of positively refining nitride inclusions and oxides during melting process, rather, JP '212 teaches restraining the growth of TiN inclusions as opposed to the concept of performing refining as a positive procedure to refine such inclusion of nitrides and oxides during melting processing.

Applicants respectfully submit that comparative data in the present specification supports Applicants' position regarding claim 1 with the addition of the limitation to claim 1 regarding the maximum length of the nitride inclusions and the maximum length of the oxide inclusions. Against that background, Applicants turn to experimental data in the specification.

The Examiner's attention is first referred to Comparative Steel No. 11 set forth at page 24.

In Comparative Steel No. 11, the Mg was 0.0002 mass% in the electrode, and 0.0001 mass% in the ingot. In accordance with the present invention, Mg is not less than 5 ppm in the consumable electrode. Comparative Steel No. 11 contains 5 ppm nitrogen in the electrode. Nitrogen in Comparative Steel No. 11 is reduced by the additive Mg to obtain nitride-type inclusions having a maximum size of 6.1 μm , which is somewhat smaller than the nitride type inclusions in JP '212. *However, the oxide type inclusions in Comparative Steel No. 11 have a very large size of 22.4 μm .* The same should be compared with the sizes of the oxide inclusions in Invention Steel Nos. 1 to 4. This illustrates the excellent effect of Mg addition in an amount of not less than 5 ppm. Applicants specifically note, in this regard, that JP '212 only focuses on TiN inclusions.

In line with the above argument, Applicants amend claim 1 by limiting the maximum length of the oxide inclusions. See page 6, lines 2-5 of the specification.

Floreen

The purpose of Floreen.

Floreen is directed to providing a maraging steel.

The Floreen Melting,

In accordance with Floreen, the melting process used is conventional melting, VIM, conventional melting + VAM or VIM+VAM.

The additive elements in Floreen.

In accordance with Floreen, aluminum is usually added for the purpose of deoxidation. Zr, B, Ca or Mg can also be added to the steel in an amount of at most 0.25% for deoxidizing and/or malleabilizing purposes.

JP '957

The purpose of JP '957.

The purpose in JP '957: to provide a maraging steel of improved resistance to stress corrosion cracking.

The a solution proposed by JP '957.

JP '957 obtains such improvement by adding Mg, Ca and/or a REM. With respect to Mg and Ca, one or both are added in the total amount of 0.01 to 0.1 wt%. This means: $0.001 \leq \text{Mg (alone)} \leq 0.1$, $0.001 \leq \text{Ca (alone)} \leq 0.1$, or $0.001 \leq \text{Mg + Ca (two)} \leq 0.1$.

It is to be specifically noted that JP '957 is silent regarding refining nitrides and/or oxides in the steel by the use of Mg during vacuum re-melting of the steel.

Smith

The purpose of Smith.

Smith is directed to providing Co-free maraging steels illustrating a combination of strength and fracture toughness.

The Smith solution.

Smith obtains such a Co-free maraging steel by adding Ti and subjecting the steel to an aging treatment.

The Smith additives.

Smith contemplates adding small amounts of up to 0.25% of Ca and/or Mg to the steel.

See Smith at col. 2, lines 9-10.

The Smith melting procedures.

Smith uses AOD + VIM + VAR, bottom of col. 2. AOD is argon-oxygen decarburization and VAR is vacuum arc re-melting.

Uehara

Uehara is simply silent on adding Mg and conducting vacuum melting twice.

Lack of Motivation to Combine JP '212 with the Other Art

The principle of the invention in JP '212.

The basic concept in JP '212 is to start with a raw material without TiN type inclusions, make a molten metal pool in VAM processing, whereas the pool is made to have a small size by controlling the rising rate of the pool, thereby shortening the agglomeration time of TiN type inclusions in the pool, and removing TiN type inclusions from the steel by vacuum electro-slag melting.

Deoxidation factors.

Ti-containing steels contains 0.03 to 0.4% Al which is a deoxidizer. Conventionally, it is unnecessary to subject a steel containing Al to melting under vacuum only to achieve oxidation,

since this increases production costs. In this regard, it should be kept in mind on the issue of motivation that Mg is more expensive than Al.

Reasons for lack of motivation to combine the other art with JP '212.

From the inventive principle of JP '212, it can be seen that the invention of JP '212 focuses on avoiding TiN type inclusions rather than refining TiN inclusions. Applicants respectfully submit that one of ordinary skill in the art from JP '212 would consider that Al is the proper and best deoxidation material for a Ti-containing steel, and would not be led to the conclusion that Mg would be preferable from any of the secondary prior art. The only reason that one of ordinary skill in the art would be led to the use of Mg is from a reading of the present specification.

Further, Applicants respectfully submit that selecting Mg in an amount of not less than 5 ppm (in consumable electrodes) would not be obvious to one of ordinary skill in the art, since it would be necessary to specifically select Mg from the optional additive elements of the other prior art and then to specify its additive amount to be not less than 5 ppm in consumable electrodes. Thus, there is a dual selection involved in reaching this aspect of the present invention.

For all of the above reasons, and considering the amendment to claim 1, withdrawal is requested.

Basis for Claim Amendments

For claim 1, see page 6, lines 2-5. For new claim 15, see page 5, lines 23-26 and 13.

AMENDMENT UNDER 37 C.F.R. § 1.111
U.S. Appl. No. 10/715,568


For claim 16, see page 33.

A translation of [0005], [0009] and [0011] of JP '212 mentioned herein is attached.

Withdrawal of the rejections and allowance is requested.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

Respectfully submitted,



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(a partial translation)

[0005]

Means for solving the problems

In order to solve the above problems, the inventor researched into a method of refining TiN type inclusions in the Ti-containing steel, especially on the subjects of a chemical composition and production processes of the steel, and found that TiN type inclusions having a size of greater than 10 μ m deteriorate fatigue durability of the steel, that TiN type inclusions contained in a raw material can not be removed by the vacuum arch re-melting method, that one method of causing the size of TiN type inclusions to be small is to make the content of TiN type inclusions smaller, and that the content of TiN type inclusions can be decreased by the Vacuum Electro-slag Melting process.

[0009]

Further, in order to solve the above problems, according to the invention method of producing the Ti-containing steel by which TiN type inclusions are refined, a rising rate of a molten metal pool in the VAM process is controlled to be not more than 0.4 cm/minute.

[0011]

It is possible to decrease impurities such as C, N, H, O and so on in the steel, to refine TiN type inclusions, and to reduce occurrence of segregation of TiN type inclusions by vacuum arch re-melting of an electrode produced by Vacuum Electro-slag Re-melting. Further, it is possible to refine TiN type inclusions by making a melting rate as low as possible (desirably, making the melting rate to be not more than 0.4 cm/minute) when re-melting the electrode produced by Vacuum Electro-slag Re-melting, since the pool in the VAM becomes small in size and depth.